

Unusual New Species of Pomatiasid Land Snails from Northern Madagascar

KENNETH C. EMBERTON

Florida Museum of Natural History, Box 117800, Gainesville, Florida 32611, USA

Abstract. Descriptions are given of three new species of pomatiasids provisionally placed in the genus *Cyclotopsis* Blanford, 1864: *C. josephinae*, *C. orchidae*, and *C. tsaratananae*. These species are unusual for their complexly reticulate sculptures in which the axial lamellae are retracted and more elevated at their junctures with the spiral cords. An identification key and diagnoses are given for the seven now known species of Madagascan *Cyclotopsis*.

INTRODUCTION

This paper is one in a series reporting taxonomic results from the author's 1992–1996 survey and inventory of Madagascar's land mollusks (references listed in Emberton, 2002).

MATERIALS AND METHODS

Materials were collected 1994–1996 using methods of Emberton et al. (1996). Generic identification and comparisons were made using Wenz (1938–1944), Fischer-Piette et al. (1993), and Emberton & Pearce (1999). Templeton's (1989) cohesion concept was applied in delimiting species. Measurements were made using an ocular micrometer on a Wild M3C dissecting microscope. Dissections were on black wax under 70% ethanol. Anatomical descriptive terminology followed Girardi (1978). Photographs were taken at standard magnifications (10×, 25×, and 40×).

LOCALITIES

Of the 1126 stations collected throughout Madagascar in 1992–1996, only the following eight stations—all northern—yielded *Cyclotopsis*.

Stations 98, 103, 104. Tsaratanana Reserve, rainforest. 98. 14°02'S, 48°47'E, 950 m, 14 June 1995. 103, 104. 14°02'S, 48°46'E, 16 June 1995. 103. 865 m. 104. 830 m.

Stations 217–219. Montagne des Orchides, 12°23'S, 49°19'E, dry deciduous forest, 20 July 1995. 217. 360 m. 218. 385 m. 219. 410 m.

Stations 233, 241. Cap d'Ambre. 233. Near lighthouse, 11°58'S, 49°16'E, 10 m, deciduous-baobab forest, 24 July 1995. 241. Near Ambatojanahary, 12°00'S, 49°17'E, 15 m, dry deciduous forest, 25 July 1995.

SYSTEMATICS

Higher classification follows Ponder & Lindberg (1997; above superfamily) and Vaught (1989; superfamily and fam-

ily). Latitudes and longitudes are given in degrees and minutes. To aid future workers, alcohol-preserved paratypes are listed separately, and species descriptions are ordered alphabetically. Types are placed in the Florida Museum of Natural History, University of Florida, Gainesville (UF); the Australian Museum, Sydney (AMS); the Academy of Natural Sciences of Philadelphia (ANSP); and the Muséum National d'Histoire Naturelle, Paris (MNHN, which does not assign catalogue numbers to types).

Class GASTROPODA

Clade CAENOGASTROPODA

Clade HYP SOGASTROPODA

Superfamily LITTORINOIDEA

Family POMATIASIDAE

Subfamily CYCLOTOPSINAE

Cyclotopsis Blanford, 1864

Key to Species of Madagascan *Cyclotopsis*:

- 1a. Axial lamellae neither retracted nor more elevated at their junctures with spiral cords 2
- 1b. Axial lamellae retracted and more elevated at their junctures with spiral cords 5
- 2a. Shell height/diameter about 0.6; spiral cords numbering about 10 on body whorl; shell and operculum bearing hairs; northern Madagascar *C. milloti*
- 2b. Shell height/diameter about 0.8–1.1; spiral cords numbering 35 or more on body whorl; shell without hairs; southern Madagascar 3
- 3a. Shell height/diameter 0.8; coiling tighter (whorls/ln diameter 2.17); aperture smaller (apertural width/shell diameter 0.35) *C. mermosi*
- 3b. Shell height/diameter 1.0–1.1; coiling looser (whorls/ln diameter 2.00–2.05); aperture smaller (apertural width/shell diameter 0.43–0.47) 4
- 4a. Spiral cords numbering about 50 on body whorl;

Table 1

Shell variation. Abbreviations: # specimen number, D1.5W diameter of first 1.5 whorls, Diam shell diameter (mm), EmW embryonic whorl count, fem female, Ht/D shell height divided by shell diameter, juv juvenile, Um/D umbilicus diameter divided by shell diameter, W/lnD whorl count divided by natural logarithm of shell diameter, Whrl whorl count.

Species	Catalog #	#	Sex	Diam	Ht/D	Whrl	W/lnD	Um/D	D1.5W	EmW
<i>josephinae</i>	UF 285452		male	5.8	0.9	3.9	2.22	0.25	1.29	1.7
<i>josephinae</i>	UF 285453	1	fem	7.1				0.28		
<i>josephinae</i>	UF 285453	2	juv						1.30	1.7
<i>josephinae</i>	AMS C.204778		juv						1.30	1.7
<i>orchidae</i>	UF 285454		fem	7.7	1.0	4.4	2.16	0.18	1.43	1.9
<i>orchidae</i>	UF 285455	1	male	5.8	0.9	3.9	2.22	0.19	1.44	1.8
<i>orchidae</i>	UF 285455	2	male	5.9	1.0	4.1	2.32	0.21	1.45	1.8
<i>orchidae</i>	UF 285455	3	fem	7.6	0.9	4.5	2.22	0.24	1.43	1.8
<i>tsaratananae</i>	UF 285456		male	5.4	1.0	3.8	2.26	0.17	1.34	1.7
<i>tsaratananae</i>	UF 285457	1	male?	6.1	0.9	3.9	2.15	0.24	1.31	1.8
<i>tsaratananae</i>	UF 285457	2	fem	6.3	0.9	4.0	2.17	0.24	1.34	1.8
<i>tsaratananae</i>	UF 285458	1	male	5.3	0.8	3.7	2.22	0.22	1.33	1.8
<i>tsaratananae</i>	UF 285458	2	fem	6.3	0.9	4.0	2.19	0.22	1.30	1.8
<i>tsaratananae</i>	UF 285580	1	male	5.6	0.9	3.7	2.14			1.7
<i>tsaratananae</i>	UF 285580	2	male	5.7	0.9	3.8	2.18		1.28	1.8
<i>tsaratananae</i>	UF 285580	3	male	5.2	0.9	3.6	2.18			1.8
<i>tsaratananae</i>	UF 285580	4	fem	6.7	0.9	3.9	2.04			1.8
<i>tsaratananae</i>	UF 285580	5	fem	6.4	0.9	4.0	2.15		1.26	1.8
<i>tsaratananae</i>	UF 285580	6	fem	6.6	0.9	4.0	2.12			1.8

- axial lamellae more widely spaced and lower standing *C. miaryi*
- 4b. Spiral cords numbering about 35 on body whorl; axial lamellae more closely spaced and higher standing *C. beviae*
- 5a. Sculpture very strong; diameter of first 1.5 whorls 1.43–1.45 mm *C. orchidae* (Figures 24–28)
- 5b. Sculpture moderate to delicate; diameter of first 1.5 whorls 1.26–1.34 mm 6
- 6a. Sculpture moderate; aperture greatly reflected downward in final 0.2 whorl; umbilicus narrower, 0.17–0.24 shell diameter; inhabiting rainforest *C. tsaratananae* (Figures 1–19)
- 6b. Sculpture delicate; aperture moderately reflected downward in final 0.1 whorl; umbilicus broader, 0.25–0.28 shell diameter; inhabiting dry-deciduous forest *C. josephinae* (Figures 20–23)

Species Diagnoses and Descriptions

Abbreviations: ad adult[s], frags fragments, juv juvenile[s]

Cyclotopsis beviae

Fischer-Piette, Blanc, Blanc & Salvat, 1993

Fischer-Piette et al., 1993: fig. 71

Diagnosis: Most similar to *C. miaryi*, with which it

shares (a) axial lamellae neither retracted nor more elevated at their junctures with the spiral cords, (b) relatively very high spire (shell height/diameter 1.0–1.1), (c) spiral cords numbering 35–50 on the body whorl, (d) shell and operculum without hairs, (e) looser coiling (whorls/ln diameter 2.00–2.05 vs. 2.17), and (f) large aperture (apertural width/shell diameter 0.43–0.47). *C. beviae* differs from *C. miaryi* in its less dense spiral cords (numbering about 35 vs. about 50 on the body whorl) and its more closely spaced and higher standing axial lamellae.

Description: Fischer-Piette et al. (1993:94–95).

Cyclotopsis josephinae Emberton, sp. nov.

(Figures 20–23)

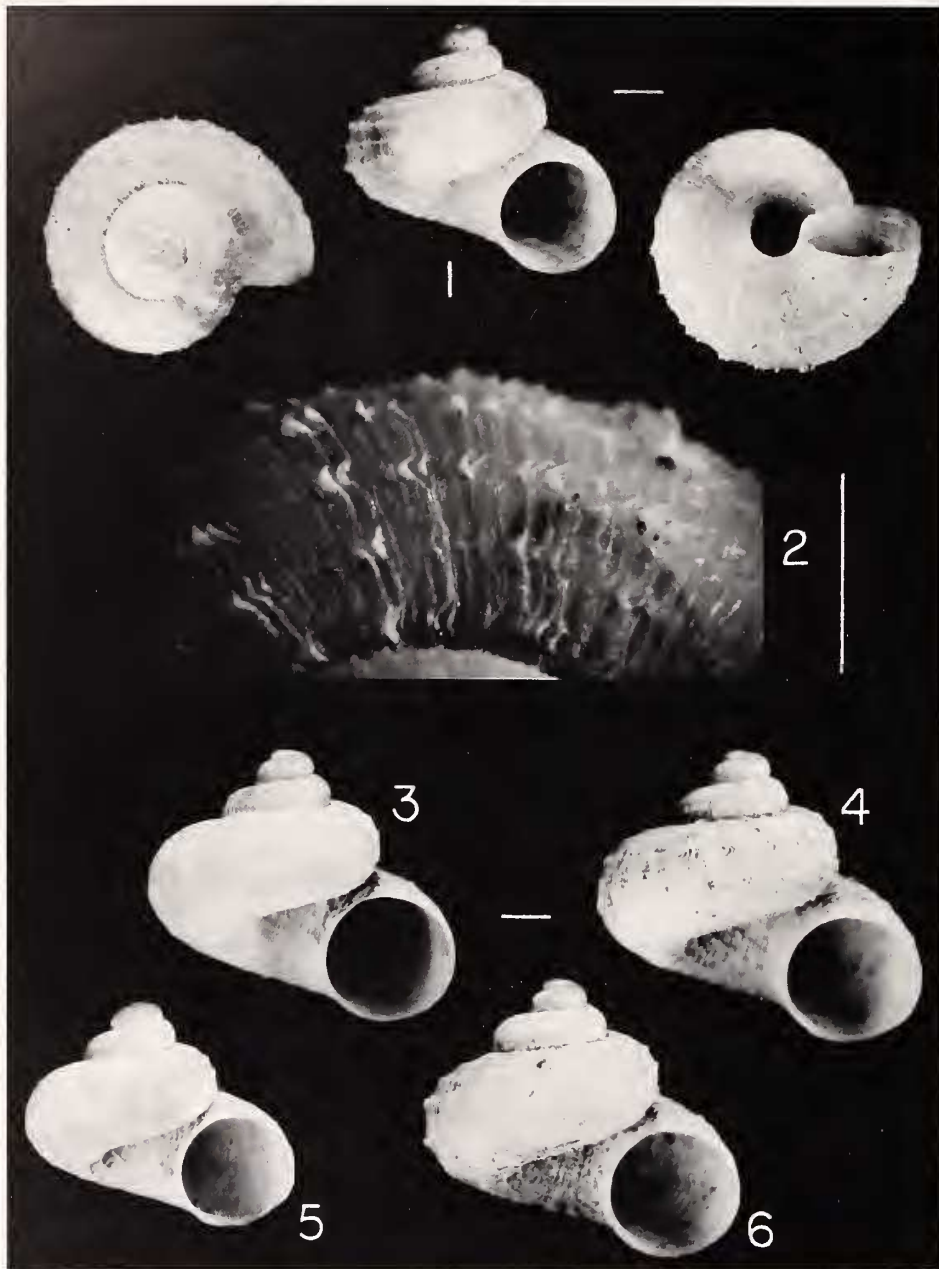
Diagnosis: Differs from *C. tsaratananae*, sp. nov. in that (a) its habitat is dry-deciduous forest (vs. rainforest), (b) its sculpture is delicate (vs. moderate), (c) its apertural downward reflection is moderate and for 0.1 whorl (vs. great and for 0.2 whorl), and (d) its umbilicus is wider (0.25–0.28 vs. 0.17–0.24 shell diameter).

Holotype: Station 241 (UF 285452, 1 ad).

Illustrated dry paratypes: Station 233 (UF 285453, 1 ad frag, 1 juv).

Other dry paratypes: Station 233 (AMS C. 204778, 1 juv; UF 285474, 1 juv frag).

Type locality: Madagascar, Cap d’Ambre, near Ambatojanahary, 12°00’S, 49°17’E, 15 m, dry deciduous forest.



Figures 1–6. Shells of *Cyclotopsis tsaratananae* Emberton, sp. nov. Figures 1, 2. Holotype (UF 285456). Figure 1. In three views. Figure 2. Magnification of dorsal body whorl. Figures 3–6. Paratypes. Figures 3, 4. From type locality (UF 285457, specimens #1 and 2, respectively). Figures 5, 6. From other locality in Tsaratanana Reserve (UF 285458, specimens #1 and 2, respectively). Scale bars = 1 mm.

Description of holotype shell (Figures 20, 21): Male. Diameter 5.8 mm, height 5.0 mm, whorls 3.9, umbilicus 1.5 mm. Spire conic. Body-whorl periphery rounded, but appearing multi-angulate due to corded sculpture; suture extremely deeply impressed, like a narrow channel; whorl shoulders flattish, sloping gently. Aperture round, height 2.4 mm, width 2.3 mm; downward deflection moderate.

0.1 whorl. Apertural lip unreflected. Embryonic whorls 1.7; first 1.5 whorls 1.29 mm in diameter. Embryonic sculpture smooth. Body-whorl sculpture a somewhat delicate reticulation produced by 11 parallel, regularly spaced spiral cords, crossed by dense, irregularly spaced, low-standing, sharp-edged, axial lamellae that are slightly retracted and sometimes raised scooplike where they

cross spiral cords. General color light beige; embryonic shell whitish with single orangish brown band at and above suture.

Shell variation: See Table 1 and Figures 20–23.

Etymology: For the author's beloved wife, Josephine Djaohasara Emberton, who, with family and friends, helped him collect this species near her home village.

Cyclotopsis mermosi

Fischer-Piette, Blanc, Blanc & Salvat, 1993

Fischer-Piette et al., 1993:fig. 69

Diagnosis: Among those Madagascan *Cyclotopsis* species with (a) axial lamellae neither retracted nor more elevated at their junctures with the spiral cords, (b) high spire (shell height/diameter 0.8–1.1), (c) spiral cords numbering 35–50 on the body whorl, and (d) shell and operculum without hairs, *C. mermosi* is diagnosed by its lower spire (shell height/diameter 0.8 vs. 1.0–1.1), tighter coiling (whorls/ln diameter 2.17 vs. 2.00–2.05), and smaller aperture (apertural width/shell diameter 0.35 vs. 0.43–0.47).

Description: Fischer-Piette et al. (1993:91–93).

Cyclotopsis miaryi

Fischer-Piette, Blanc, Blanc & Salvat, 1993

Fischer-Piette et al., 1993:fig. 70

Diagnosis: Differs from *C. beviae* in its denser spiral cords (numbering about 50 vs. about 35 on the body whorl) and its more widely spaced and lower standing axial lamellae.

Description: Fischer-Piette et al. (1993:93–94).

Cyclotopsis milloti

Fischer-Piette, Blanc & Vukadinovic, 1974

Fischer-Piette et al., 1974:fig. 9

Fischer-Piette et al., 1993:fig. 69

Diagnosis: Among those Madagascan *Cyclotopsis* species with axial lamellae neither retracted nor more elevated at their junctures with the spiral cords, *C. milloti* is unique in its (a) very low spire (shell height/diameter 0.6 vs. 0.8–1.1), (b) spiral cords numbering about 10 (vs. 35–50) on the body whorl, and (c) shell and operculum bearing hairs (vs. no hairs).

Description: Fischer-Piette et al. (1974:472); Fischer-Piette et al. (1993:91–93).

Cyclotopsis orchidae Emberton, sp. nov.

(Figures 24–28)

Diagnosis: Among those Madagascan *Cyclotopsis* species with axial lamellae retracted and more elevated at

their junctures with the spiral cords, *C. orchidae*, sp. nov. is unique in its very strong (vs. moderate to delicate) sculpture and in its relatively large initial whorl (diameter of first 1.5 whorls 1.43–1.45 mm vs. 1.26–1.34 mm).

Holotype: Station 218 (UF 285454, 1 ad).

Illustrated dry paratypes: Station 218 (UF 285455, 3 ad).

Other dry paratypes: Station 217 (UF 285525, 10 ad, 2 juv); 218 (AMS C. 203505, 1 ad; ANSP 407919, 1 ad; MNHN, 1 ad; UF 285524, 15 ad, 24 juv); 219 (UF 285526, 2 ad).

Type locality: Madagascar, Montagne des Orchides, 12°23'S, 49°19'E, 385 m, dry deciduous forest.

Description of holotype shell (Figures 24, 25): Female. Diameter 7.7 mm, height 7.9 mm, whorls 4.4, umbilicus 1.4 mm. Spire conic. Body-whorl periphery rounded, but appearing multi-angulate due to corded sculpture; suture extremely deeply impressed, like a narrow channel; whorl shoulders flattish, sloping gently. Aperture round; height 3.3 mm, width 3.3 mm; downward deflection great, 0.2 whorl. Apertural lip mostly unreflected, with very slight and narrow reflection at the columella. Embryonic whorls 1.9; first 1.5 whorls 1.43 mm in diameter. Embryonic sculpture smooth. Body-whorl sculpture a large, gross reticulation produced by about 15 parallel, regularly spaced spiral cords, crossed by very thin, high-standing, irregularly spaced axial lamellae that are taller and slightly retracted where they cross spiral cords. General color grayish yellow-brown; apex brownish yellow with single reddish brown band.

Shell variation: See Table 1 and Figures 24–28.

Etymology: For Montagne des Orchides.

Cyclotopsis tsaratananae Emberton, sp. nov.

(Figures 1–19)

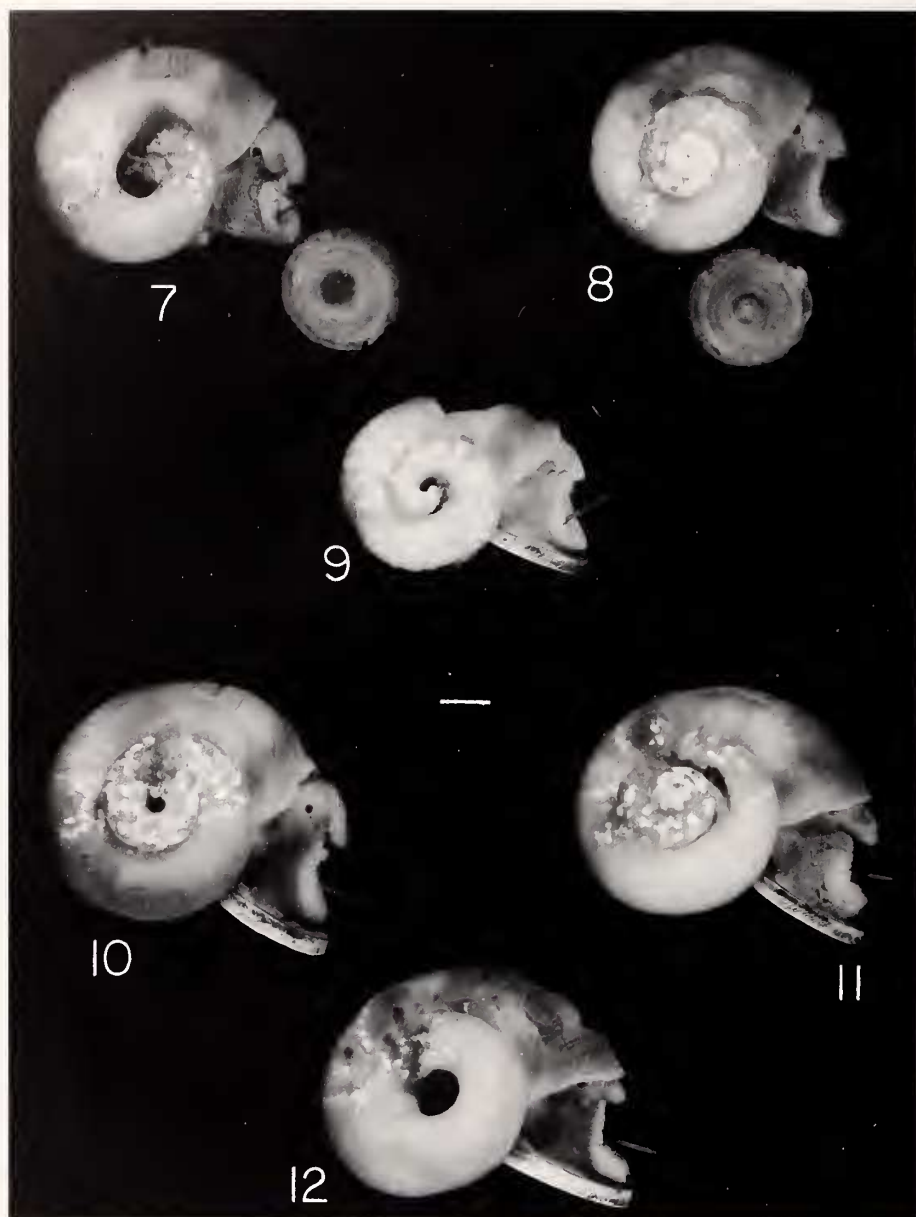
Diagnosis: Differs from *C. josephinae*, sp. nov. in that (a) its habitat is rainforest (vs. dry-deciduous-forest), (b) its sculpture is moderate (vs. delicate), (c) its apertural downward reflection is great and for 0.2 whorl (vs. moderate and for 0.1 whorl), and (d) its umbilicus is narrower (0.17–0.24 vs. 0.25–0.28 shell diameter).

Holotype: Station 98 (UF 285456, 1 ad).

Illustrated dry paratypes: Stations 98 (UF 285457, 2 ad); 103 (AMS C. 204779, 1 operc; ANSP 407921, 1 operc; MNHN, 1 operc; UF 285458, 2 ad, 3 operc).

Illustrated alcohol paratypes: Station 103 (UF 285580, 6 ad [dissected]).

Other dry paratypes: Stations 98 (AMS C. 203506, 1 ad; ANSP 407920, 1 ad; MNHN, 1 ad; UF 285576, 12



Figures 7-12. Bodies (shells removed) of *Cyclotopsis tsaratananae*, Emberton, sp. nov. (UF 285580). Figures 7-9. Males, specimens #1-3, respectively. Figures 10-12. Females, specimens #4-6, respectively. Scale bar = 1 mm.

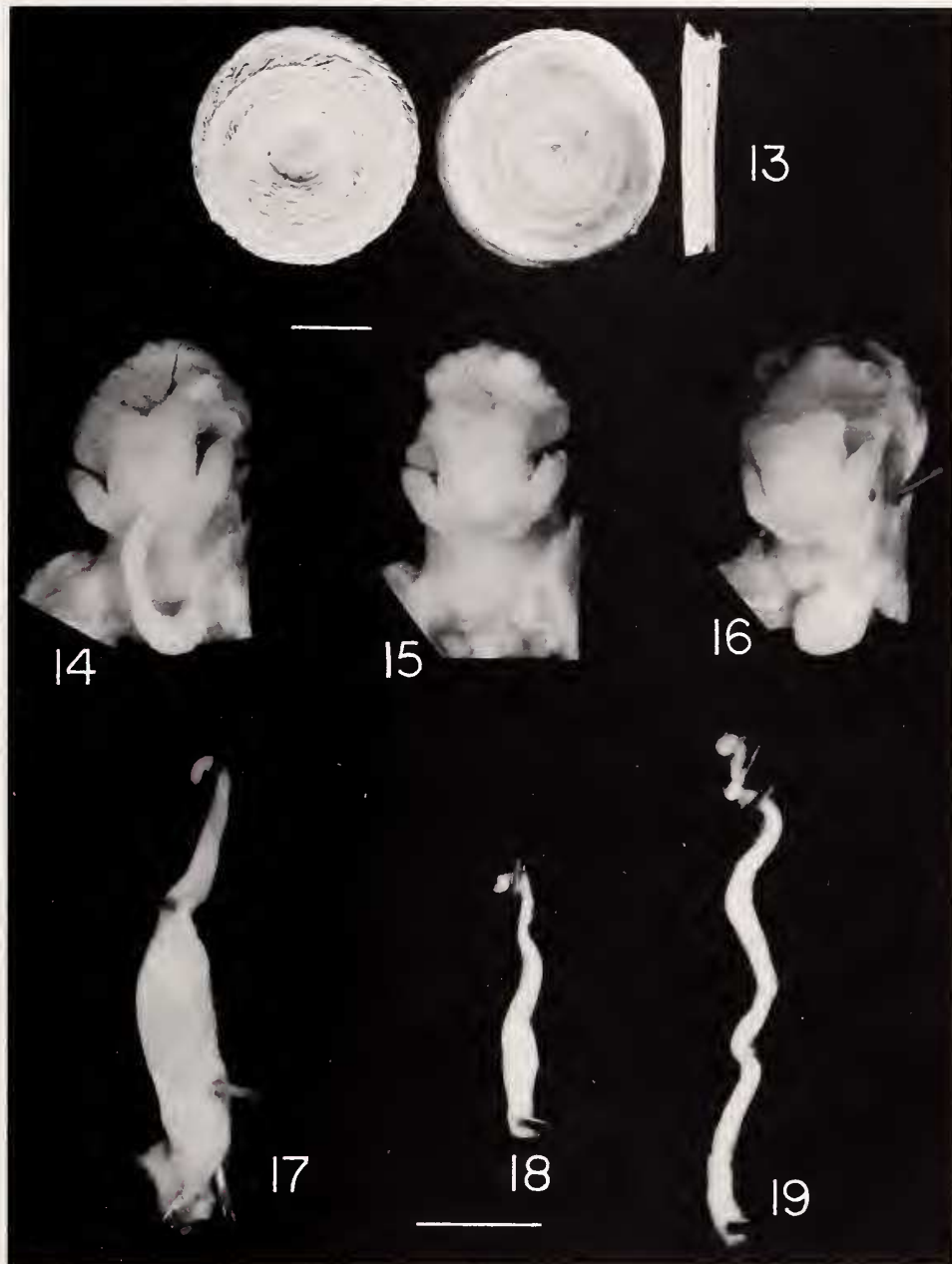
ad, 13 juv); 103 (UF 285575, 10 ad, 13 juv); 104 (1 ad, UF 285574).

Other alcohol paratypes: Stations 98 (UF 285578, 2 ad, 2 juv); 103 (UF 285579, 11 ad, 9 juv); 104 (UF 285577, 2 ad).

Type locality: Madagascar, Tsaratanana Reserve, 14°02'S, 48°47'E, 950 m, rainforest.

Description of holotype shell (Figures 1, 2): Male. Di-

ameter 5.4 mm, height 5.3 mm, whorls 3.8, umbilicus 0.9 mm. Spire conic. Body-whorl periphery rounded, but appearing multi-angulate due to corded sculpture; suture extremely deeply impressed, like a narrow channel; whorl shoulders flattish, sloping gently. Aperture round; height 2.3 mm, width 2.4 mm; downward deflection great, 0.2 whorl. Apertural lip unreflected. Embryonic whorls 1.7; first 1.5 whorls 1.34 mm in diameter. Embryonic sculpture smooth. Body-whorl sculpture a strong reticulation produced by about 14 parallel, regularly spaced spiral cords, and dense,



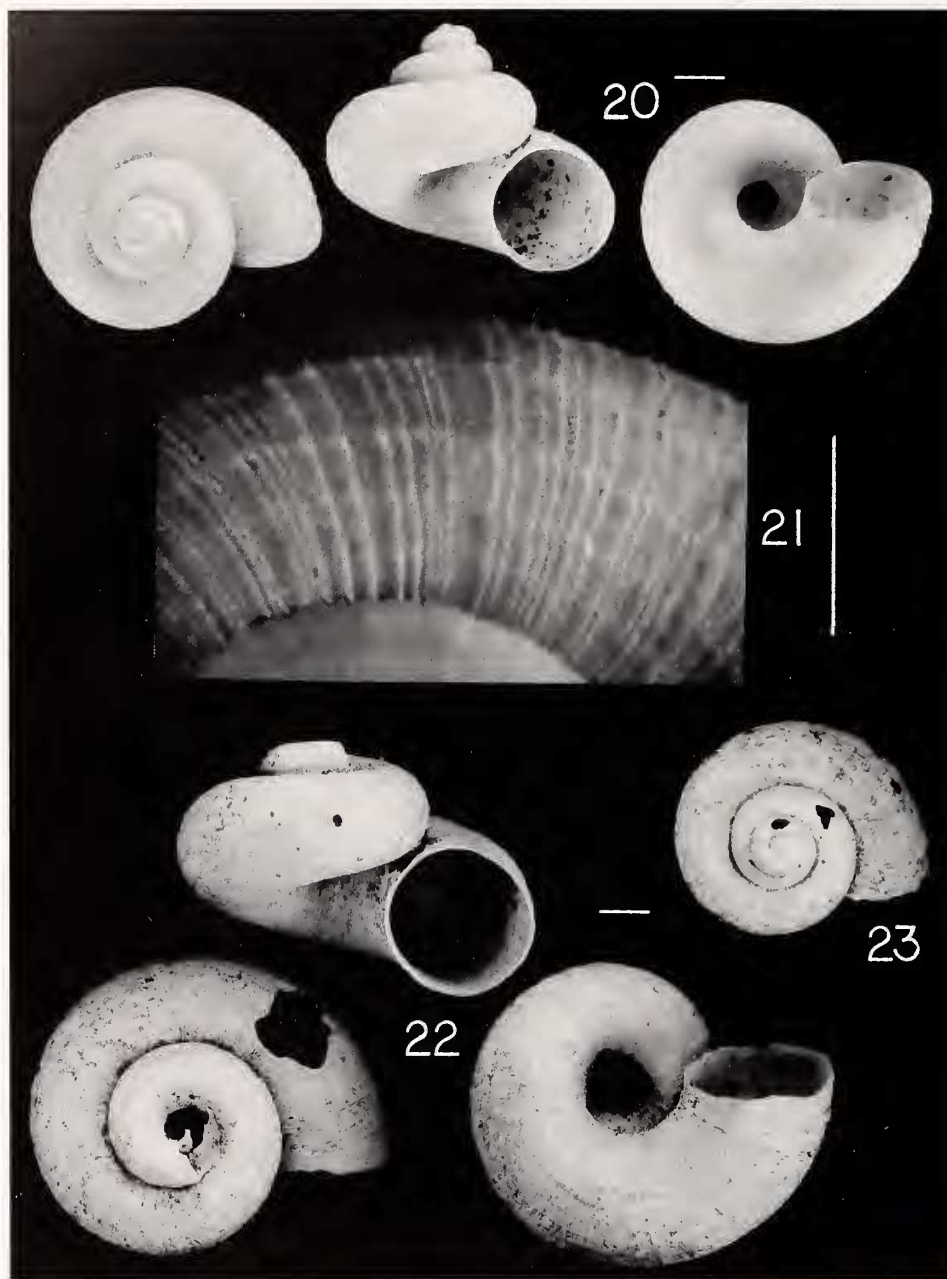
Figures 13–19. *Cyclotopsis tsaratananae* Emberton, sp. nov. (UF 285580). Figure 13. Operculum (specimen #4) in external, internal, and side views (left to right). Figures 14–16. Dorsal views of head and penis, with mantle removed (specimens #1–3, respectively). Figure 17. Penis in dorsal view, extended (specimen #3). Figures 18, 19. Oviduct-plus-seminal receptacle-plus-bursa copulatrix of females, (specimens #4 and 5, respectively). Scale bars = 1 mm.

irregularly spaced, low, sharp, axial lamellae that retract and raise scooplike where they cross spiral cords. General color grayish brown-yellow; apex light reddish brown.

Shell variation: See Table 1 and Figures 1–6.

Operculum (Figures 7, 8, 13): Circular, slightly flattened along parietal edge. Very thick, calcified and white

throughout, except for a horny, yellow-brown layer on the interior surface that slightly detaches and curves inward at parietal edge. Nucleus virtually central, with embryonic whorls forming, on the external surface, a depressed, circular, translucent “window” (best seen in Figure 7). Periphery of operculum excavated just below its interior, horny surface in a deep, very narrow channel.

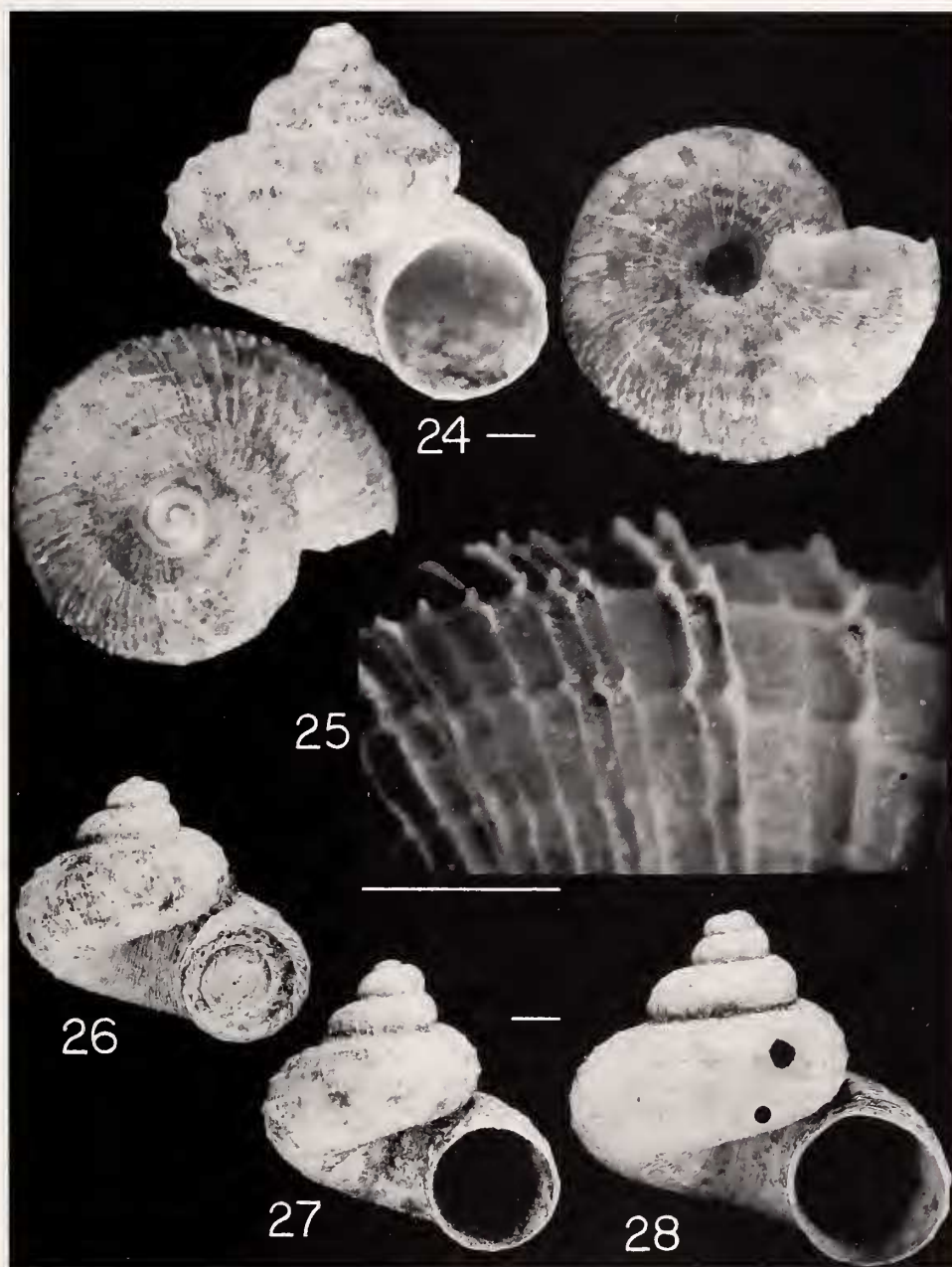


Figures 20–23. Shells of *Cyclotopsis josephinae* Emberton, sp. nov. Figures 20, 21. Holotype (UF 285452). Figure 20. In three views. Figure 21. Magnification of dorsal body whorl. Figures 22, 23. Paratypes (UF 285453). Figure 22. Adult female fragment, in three views. Figure 23. Juvenile in apical view. Scale bars = 1 mm.

Exterior to this channel, opercular periphery expands outward—rapidly at parietal edge, slower elsewhere—to exterior surface, giving operculum a somewhat bilayered appearance, with exterior layer (surface) slightly larger than interior. Post-embryonic whorls tightly and evenly coiled, demarcated on external surface by coarse, parallel, fibrous- or crystalline-looking structures arranged in two different ways forming two distinct types of spiral bands:

tightly bound spirals and loosely bound angular radiations. Internal surface smooth, glossy, with only slight spiral relief. Peripheral edge formed of loose-bound structures.

Anatomy (Figures 7–19, ethanol-fixed and -preserved): Foot relatively short and broad, longitudinally divided in half by a deep, central fissure (Figures 14–16). Snout moderately long, broad, divided into two lobes by



Figures 24–28. Shells of *Cyclotopsis orchidae* Emberton, sp. nov. Figures 24, 25. Holotype (UF 285454). Figure 24. In three views. Figure 25. Magnification of dorsal body whorl. Figures 26–28. Paratypes from type locality (UF 285455, specimens #1–3, respectively). Scale bars = 1 mm.

a shallow, broad central cleft (Figures 14–16). Body a very light orange-gray, darker gray on sides; mantle orangish cream with dense gray stippling at its anterior edge and sometimes with blackish-stippled outlining of one or more branching arteries. Digestive gland with many sacculs containing a white, refractive material (Figures 7–12). Testis small, lying along inside curve of apical di-

gestive gland. Penis simple, muscular, with a broad basal two-thirds and a narrow, tapered-tubular apical one-third, total length uncoiled about 3.2 mm (Figures 16, 17), but sometimes merely a medium-width tube enlarging slightly before its then slightly tapered tip (Figure 14), and sometimes no more than a tiny, low nub (Figure 15; developmental stages?). Ovary small, lying along inside

curve of apical digestive gland, apparently a glandular-looking tube without acini. Female reproductive tract (Figures 18, 19) a simple tube without accessory sacs; seminal-receptacle and bursa-copulatrix regions slightly to moderately swollen, slightly to moderately C-curved, and demarked from each other—and seminal receptacle demarked from oviduct—by sharper bends.

Etymology: For Tsaratanana Reserve.

Acknowledgments. Collection, sorting, housing, and identification funded by U.S. National Science Foundation (DEB 9201060/9596032); description funded by Owen Griffiths. Permits issued by Madagascar government agencies DEF and AN-GAP. Ranomafana National Park Project gave logistic support. Very many people collected or otherwise assisted, but particular thanks go to Dr. Tim Pearce, Owen Griffiths, Jean Rakotoarison, and the late Max Felix Rakotomalala. Dr. Fred Thompson and two anonymous reviewers gave useful comments on drafts of the manuscript.

LITERATURE CITED

- EMBERTON, K. C. 2002. *Ankoravaratra*, a new genus of land snails endemic to northern Madagascar (Cyclophoroidea: Maizaniidae?). *The Veliger* 45:278–289.
- EMBERTON, K. C. & T. A. PEARCE. 1999. Land caenogastropods from Mounts Mahermana, Ilapiry, and Vasiha, southeastern Madagascar, with conservation statuses of 17 species of *Boucardicus*. *The Veliger* 42:338–372.
- EMBERTON, K. C., T. A. PEARCE & R. RANDALANA. 1996. Quantitatively sampling land-snail species richness in Madagascar rainforests. *Malacologia* 38:203–212.
- FISCHER-PIETTE, E., C. P. BLANC, F. BLANC & F. SALVAT. 1993. Gastéropodes terrestres prosobranches. *Faune de Madagascar* 80:1–281.
- GIRARDI, E.-L. 1978. The Samoan land snail genus *Ostodes* (Mollusca: Prosobranchia: Poterriidae). *The Veliger* 20:191–250.
- PONDER, W. F. & D. R. LINDBERG. 1997. Towards a phylogeny of gastropod molluscs: an analysis using morphological characters. *Zoological Journal of the Linnean Society* 119: 83–265.
- TEMPLETON, A. R. 1989. The meaning of species and speciation: A genetic perspective. Pp. 3–27 in D. Otte & J. A. Endler (eds.), *Speciation and Its Consequences*. Sinauer Associates: Sunderland, Massachusetts.
- VAUGHT, K. C. 1989. *A Classification of the Living Mollusca*. American Malacologists Inc.: Melbourne, Florida.
- WENZ, W. 1938–1944. *Gastropoda, Teil 1: Allgemeiner Teil und Prosobranchia*. Band 6. Pp. 1–1639 in O. H. Schindewolf (ed.), *Handbuch der Paläozoologie*. Gebrüder Bornträger: Berlin.